

UNCLASSIFIED

## Defense Technical Information Center Compilation Part Notice

ADP011184

TITLE: Space and Missile Defense Technical Center Briefing for  
AIAA/BMDO Technology Conference and Exhibit

DISTRIBUTION: Approved for public release, distribution unlimited

This paper is part of the following report:

TITLE: The Annual AIAA/BMDO Technology Conference [10th] Held in  
Williamsburg, Virginia on July 23-26, 2001. Volume 1. Unclassified  
Proceedings

To order the complete compilation report, use: ADB273195

The component part is provided here to allow users access to individually authored sections  
of proceedings, annals, symposia, etc. However, the component should be considered within  
the context of the overall compilation report and not as a stand-alone technical report.

The following component part numbers comprise the compilation report:

ADP011183 thru ADP011193

ADP204784 thru ADP204818

UNCLASSIFIED

**UNCLASSIFIED**



# **Space and Missile Defense Technical Center**

***Briefing for  
AIAA/BMDO Technology  
Conference and Exhibit  
23 July 2001***

**Jess Granone  
Director**



DISTRIBUTION STATEMENT A: Approved for public release; distribution is unlimited.

**UNCLASSIFIED**

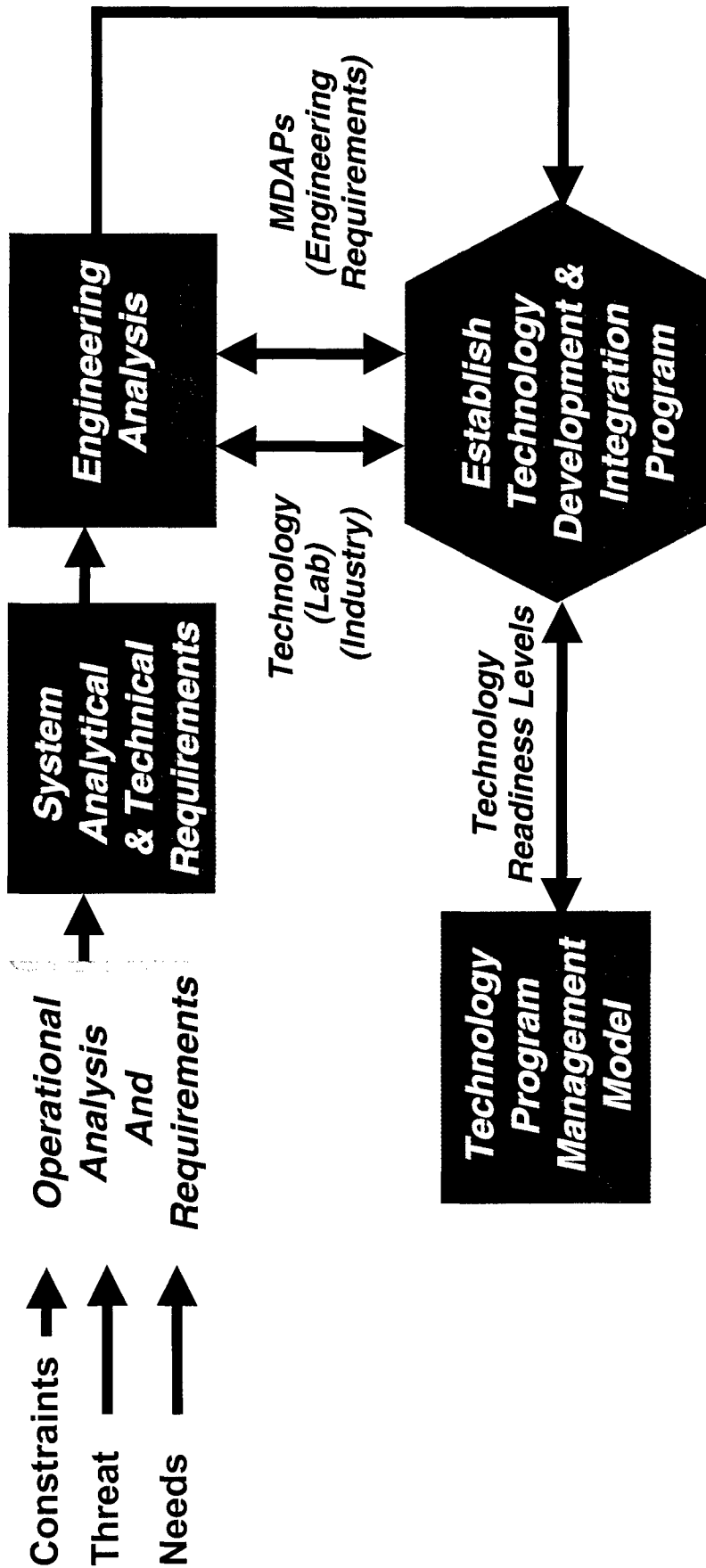


UNCLASSIFIED

*Army Space and Missile Defense Command*



# Process To Develop Technology Program



**Analytically Based Technology Program Defined**

"Secure the High Ground"

UNCLASSIFIED



UNCLASSIFIED

*Army Space and Missile Defense Command*



# **Threat (ECM Environment)**

Hundreds of X-band  
chaff clouds produced  
by COTS A/C chaff  
cartridges

Dozens of RV-size  
residual-air balloons  
fabricated from COTS  
materials

Small quantity of nuclear-  
armed RVs covered with  
COTS RAM

10-20 RV-size  
booster segments

UNCLASSIFIED

"Secure the High Ground"



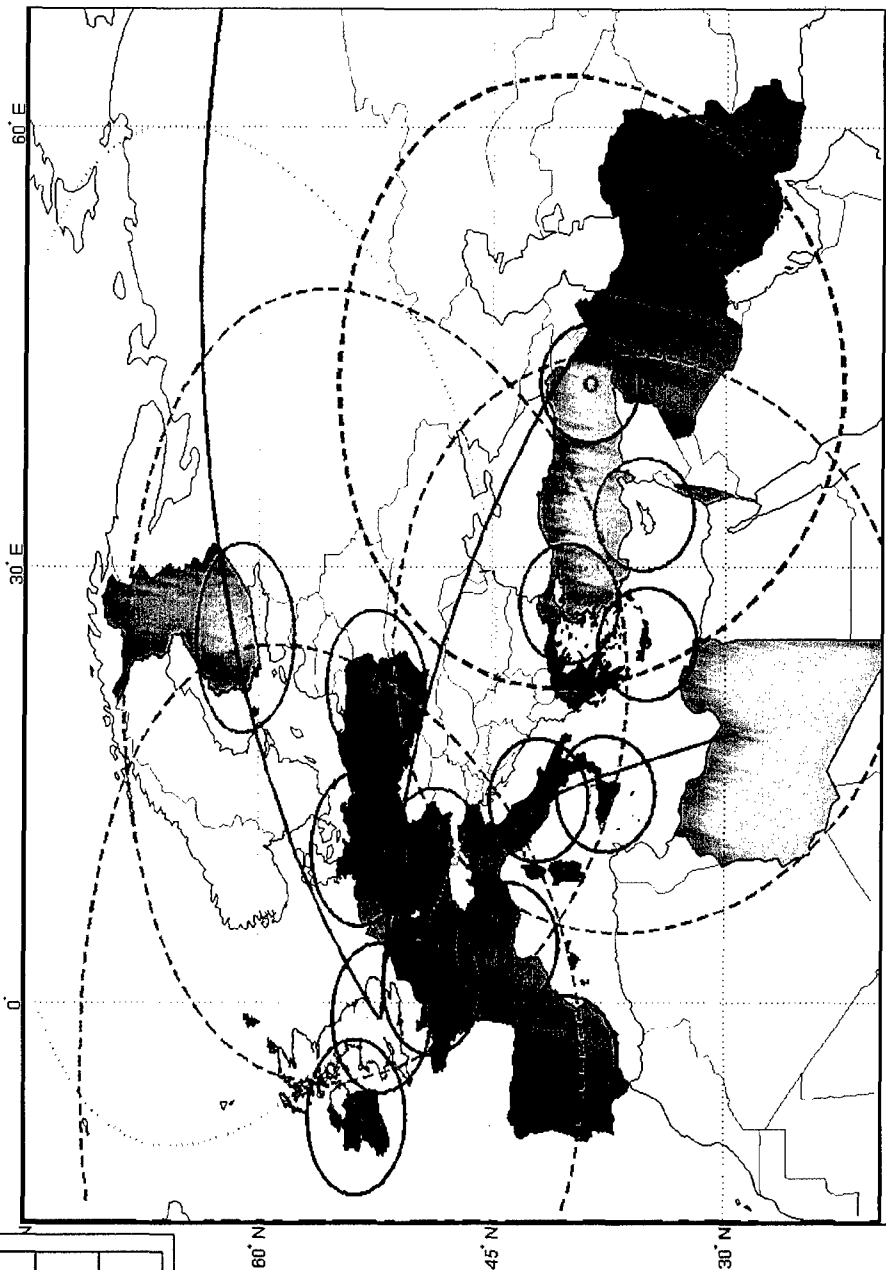
UNCLASSIFIED

*Army Space and Missile Defense Command*

# Notional Missile Defense Laydown



|        |
|--------|
| Zoom   |
| Rotate |
| Origin |



UNCLASSIFIED

"Secure the High Ground"



UNCLASSIFIED

*Army Space and Missile Defense Command*



## ***Characteristics of a Robust Missile Defense System***

- Multi-Tiered to support Shoot-Look-Shoot engagements; Multiple intercepts within a Tier
- EO/IR sensor to support target acquisition and first intercept
- Track and Fire Control Radar to support target discrimination and mid-course/ENDO engagements
- BMC4I System that fuses EO/IR Sensor and Radar data providing a Common Air Picture to all Nodes
- Missiles with Multiple payloads
  - *Mini-Interceptors to Strip out balloons and Debris*
  - *Dust to Remove Chaff*
  - *Single Interceptor to Kill RV*

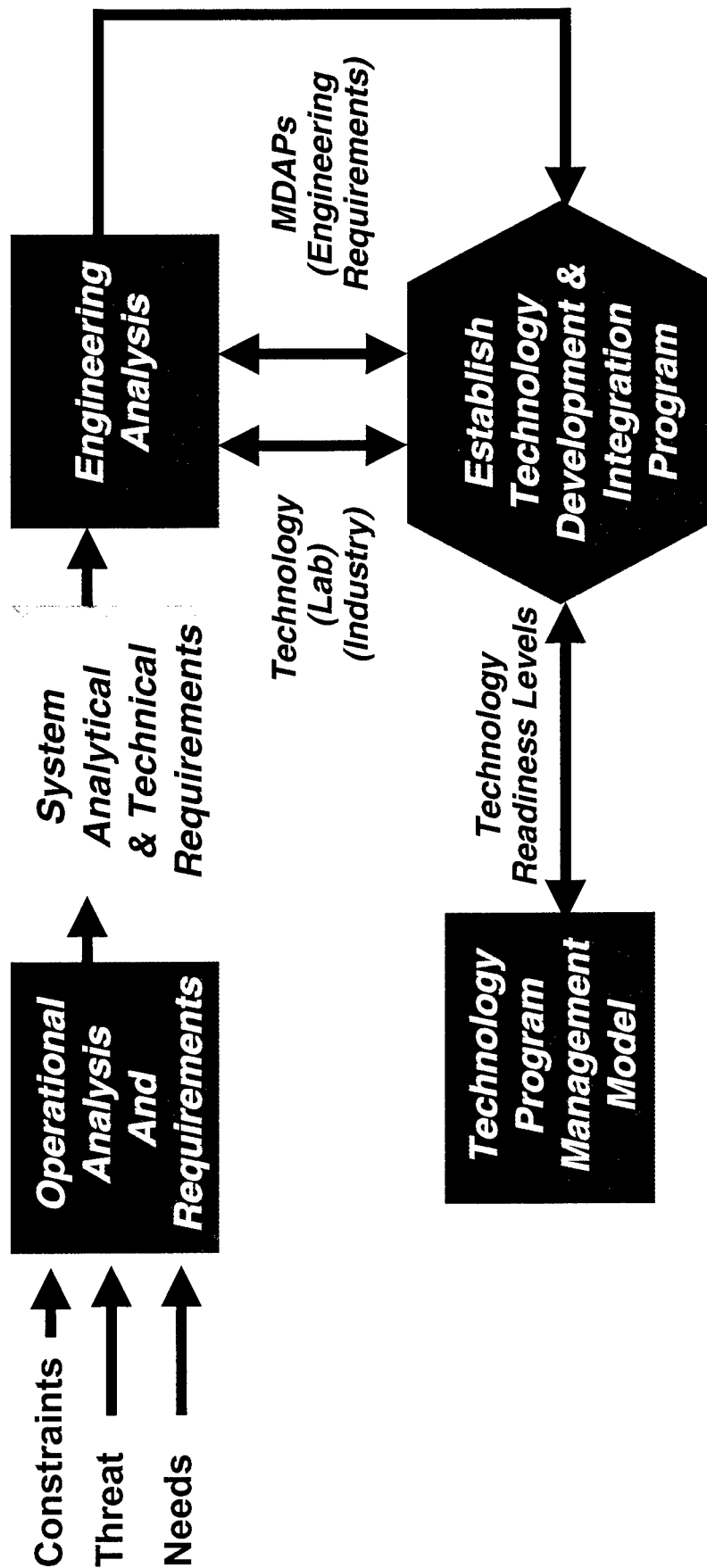


UNCLASSIFIED

*Army Space and Missile Defense Command*



# Process To Develop Technology Program



*Analytically Based Technology Program Defined*

"Secure the High Ground"

UNCLASSIFIED

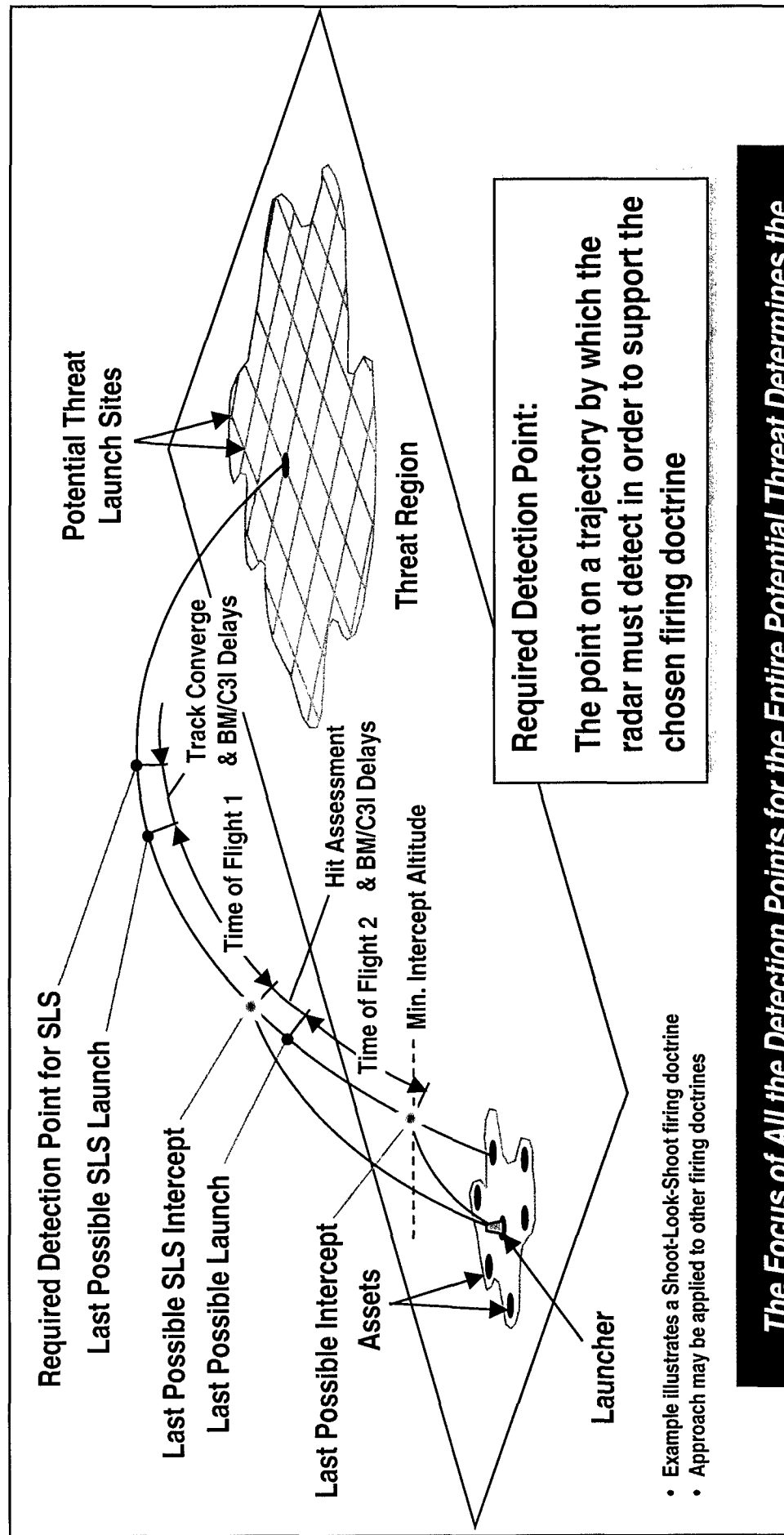


UNCLASSIFIED

*Army Space and Missile Defense Command*



# Definition of Required Detection Point



***The Focus of All the Detection Points for the Entire Potential Threat Determines the Region in Space Which Must Be Searched in Order to Meet Mission Objectives***

*"Secure the High Ground"*

UNCLASSIFIED



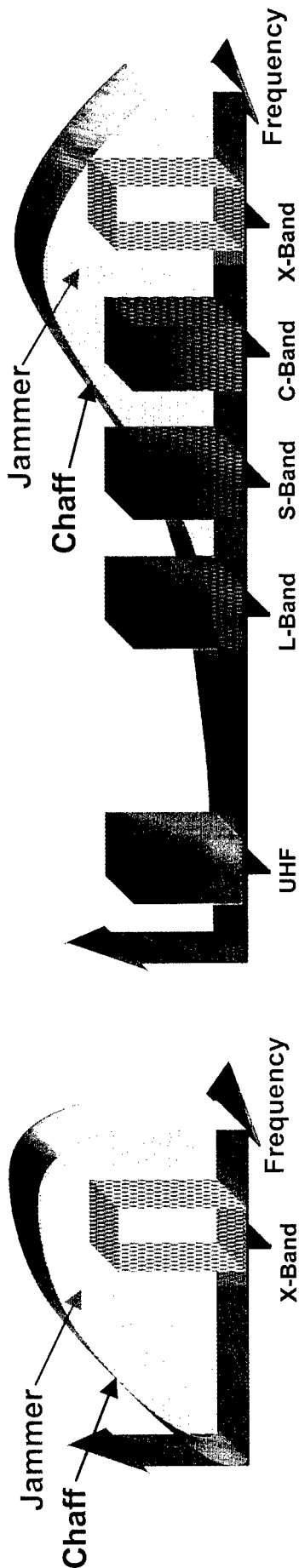


UNCLASSIFIED

*Army Space and Missile Defense Command*



# Multi-Band Counter-Countermeasures Benefit



## Single-Band Operation

- In-Band Jammer Severely Degrades Radar Operation
  - ▶ Jammer Burn-Through Drives Transmitted Power up and Reduces Battlespace
  - ▶ Advanced ECCM Required to Mitigate Jammer and Recover Battlespace
- Visibility in Chaff Requires Advanced Techniques
  - ▶ Range-Doppler Imaging Drives Radar Resource Requirements
  - ▶ Polarization Techniques Require Simultaneous Dual-Polarization Reception
- Percent-Bandwidth Pushed to Extremes to Reduce Jammer and Chaff Effectiveness

## S-UWB Operation

- Jammer Severely Degrades One Band - Other Bands Unaffected
- Chaff Affects Some Bands More Than Others - Allows Radar to Optimize Resources to Best Mitigate Chaff
- Percent-Bandwidth in Each Sub-Band Can Be Small While Still Achieving Excellent Jammer and Chaff Mitigation

*"Secure the High Ground"*

UNCLASSIFIED

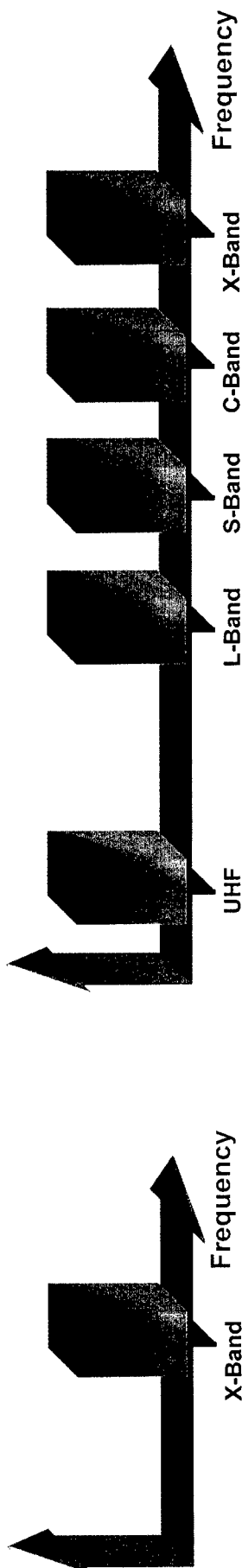


UNCLASSIFIED

*Army Space and Missile Defense Command*



## Multi-Band Discrimination Benefits



### Single-Band Operation

- Threat Can Effectively Match Decoy and RV RCS in a Single Band
- Precision Decoys Drive Radar to High-Resolution Range-Doppler Imaging and Potentially Long Discrimination Timelines
- Discrimination in Chaff and Jamming is Severely Degraded

### S-UWB Operation

- Extremely Difficult to Match RCS From UHF to X-Band
- RCS Measured in Multiple Bands Leads to Unique and Effective Discriminants
  - ▶ Material Property Measurement (Like Infrared Temperature Measurement Techniques)
  - ▶ Multiple Polarizations Across Bands Add Additional Features
  - ▶ Bands Can Be Coherently Combined to Achieve High Range Resolution
- Discrimination in Chaff and Jamming Enhanced Due to Unique S-UWB Features

UNCLASSIFIED

*"Secure the High Ground"*

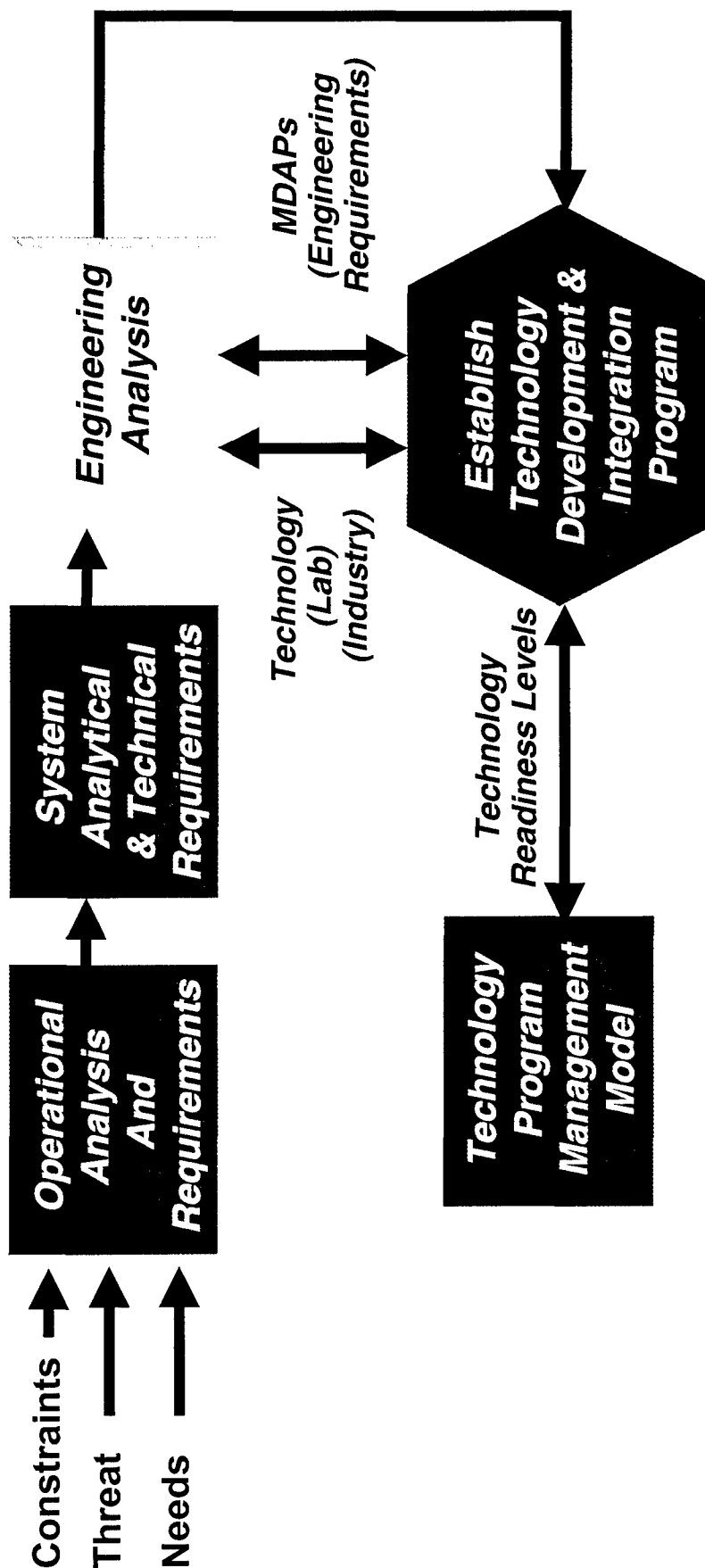


UNCLASSIFIED

*Army Space and Missile Defense Command*



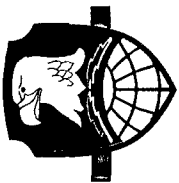
# Process To Develop Technology Program



*Analytically Based Technology Program Defined*

*"Secure the High Ground"*

UNCLASSIFIED



UNCLASSIFIED

*Army Space and Missile Defense Command*



# ***RADAR Requirements and Technologies***

- Common Hardware/Software Architecture
- Transportable
- Detection/Tracking range ~ 1800 km
  - *SiC/GaN T/R modules*
  - *Temperature Management*
  - *STAP Processing*
  - *-- Requires New Aperture Design*
- Threat Characterization/Discrimination/Counter-Countermeasures
  - *Ultra Wide Band (Chaff, image objects)*
  - *Multi-band (RCS/Reduction/Discrimination chaff, jammers)*
  - *Requires Multi-band subarrays (minimum of 70 subarrays)*
  - *-- Requires New Aperture and Signal Processing Design*

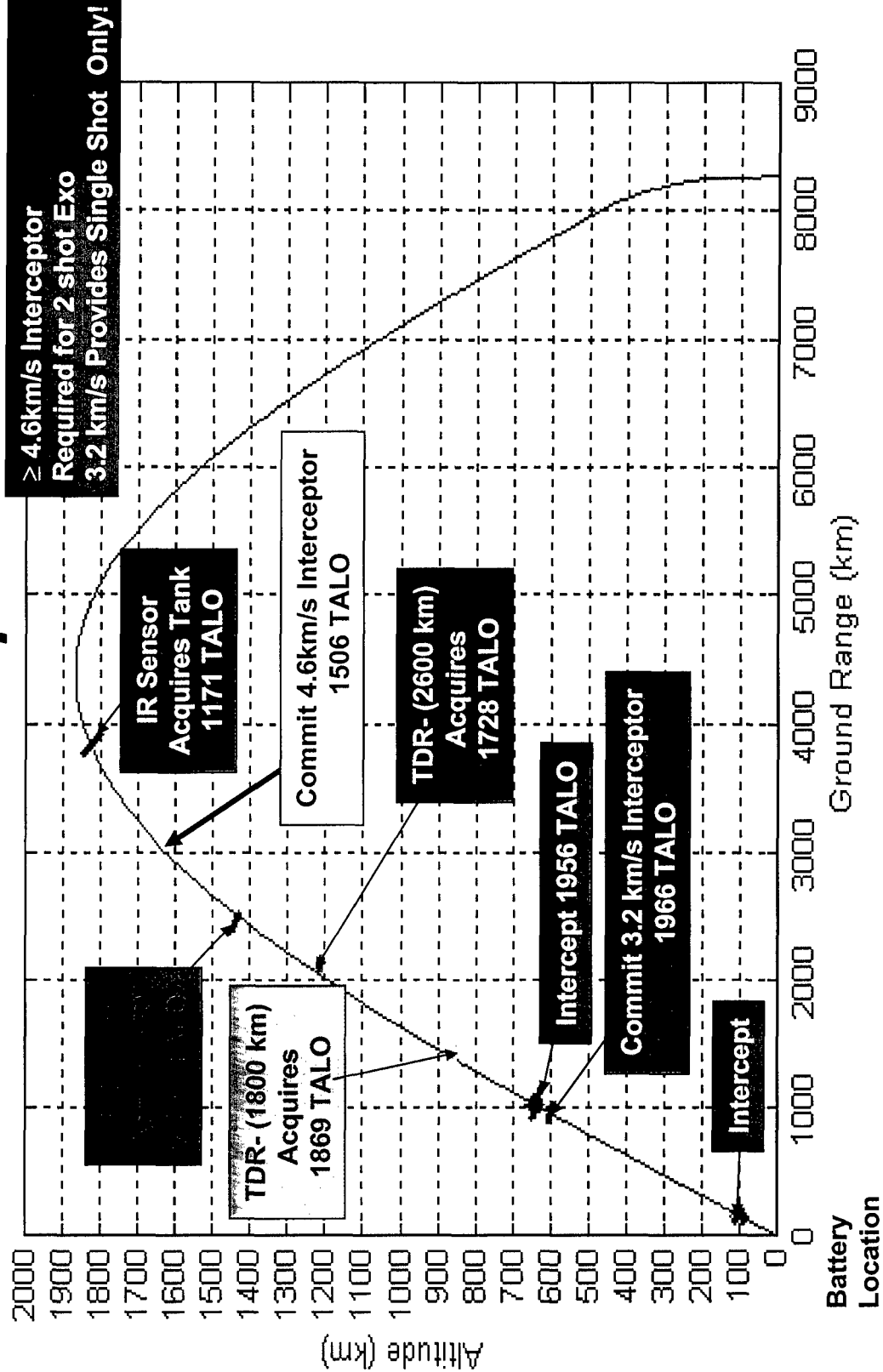


UNCLASSIFIED

Army Space and Missile Defense Command



# Two-Shot Exo-Battlespace Self Defense Example



"Secure the High Ground"

UNCLASSIFIED

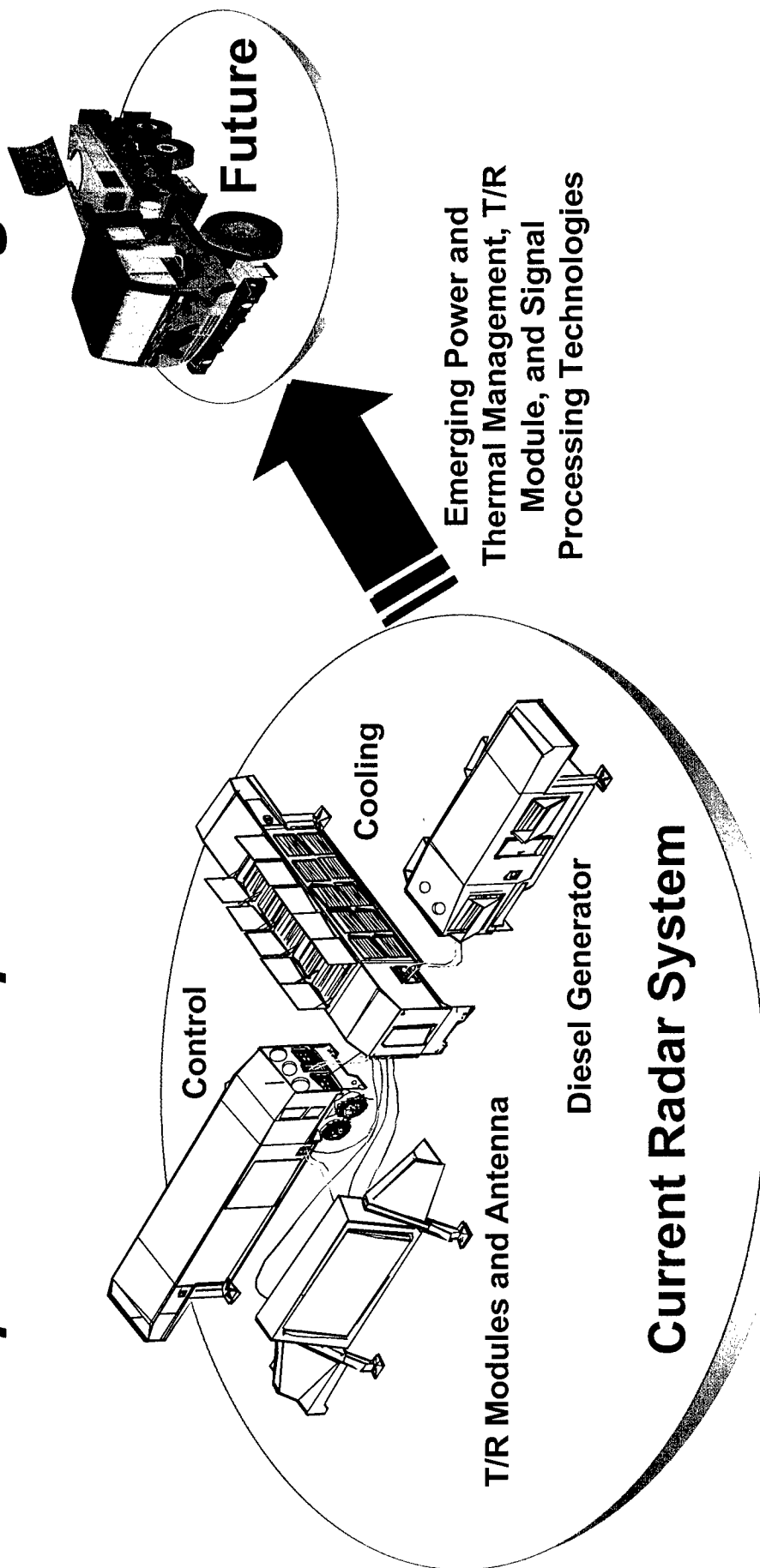


UNCLASSIFIED

*Army Space and Missile Defense Command*



# Concept of Transportable Discriminating Radar



*Increased Capability, Mobility, Deployability, Survivability with Reduced Logistics Tail*

*"Secure the High Ground"*

UNCLASSIFIED

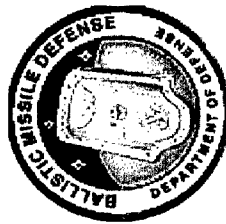


*Army Space and Missile Defense Command*

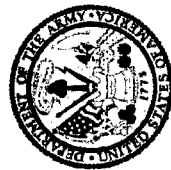
UNCLASSIFIED



## Leveraged Programs



- New Multi-band Radar Design IPT: SMDC, ART, USAF, USN, Industry, Academia
- ART Programs: Adaptive Digital Beam Forming, GaN Amplifiers, Power, High Tolerant Signal Processing
- Antenna Design (GTRI)
- Multi-band Coherent Processing (MIT/LL)
- All Digital Radar

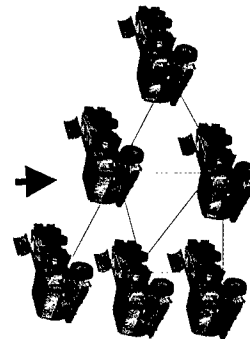


- Radar Power Generation (SMDC)
- RF Interferometer (SMDC)

Multi-band Testing  
(Rome Labs)

New Multi-band Radar

Distributed Multi-band Radar



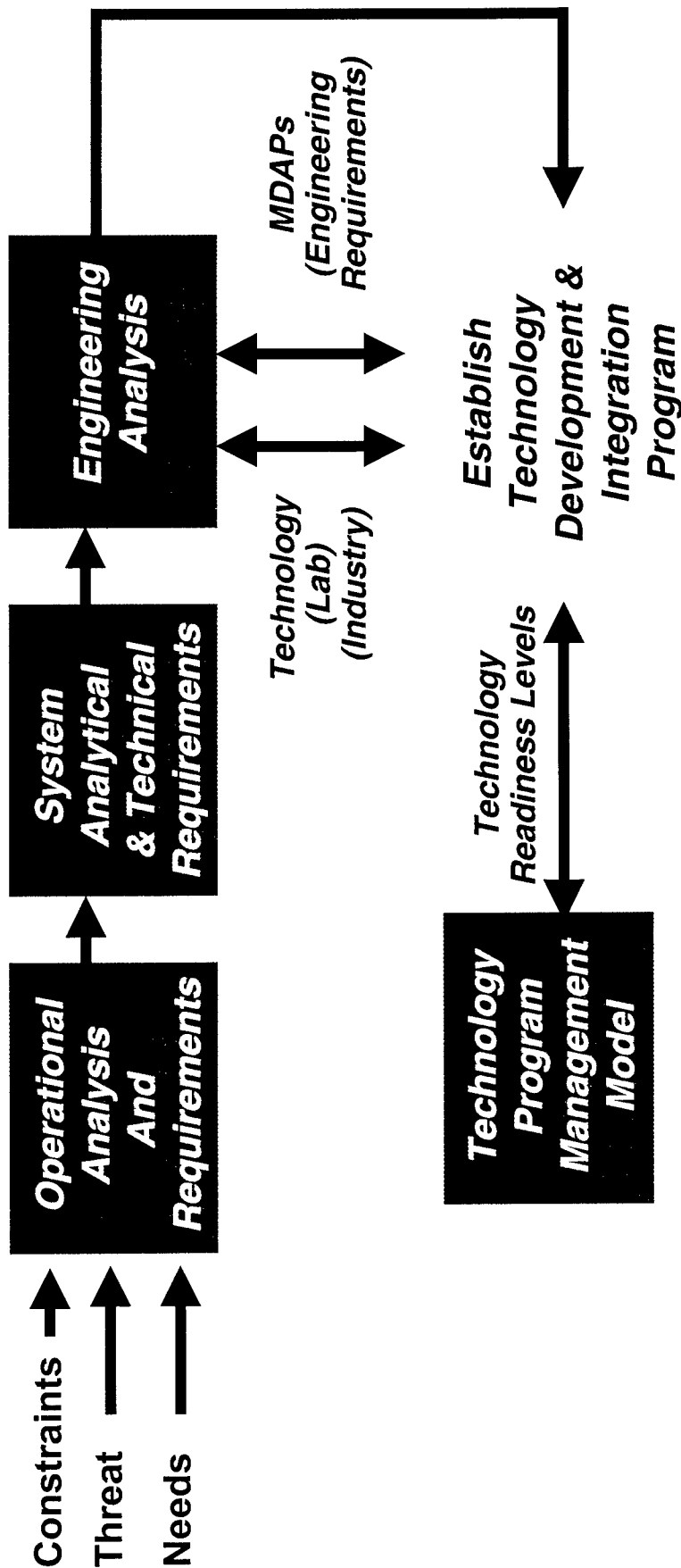


UNCLASSIFIED

*Army Space and Missile Defense Command*



# *Process To Develop Technology Program*



*Analytically Based Technology Program Defined*

UNCLASSIFIED

"Secure the High Ground"



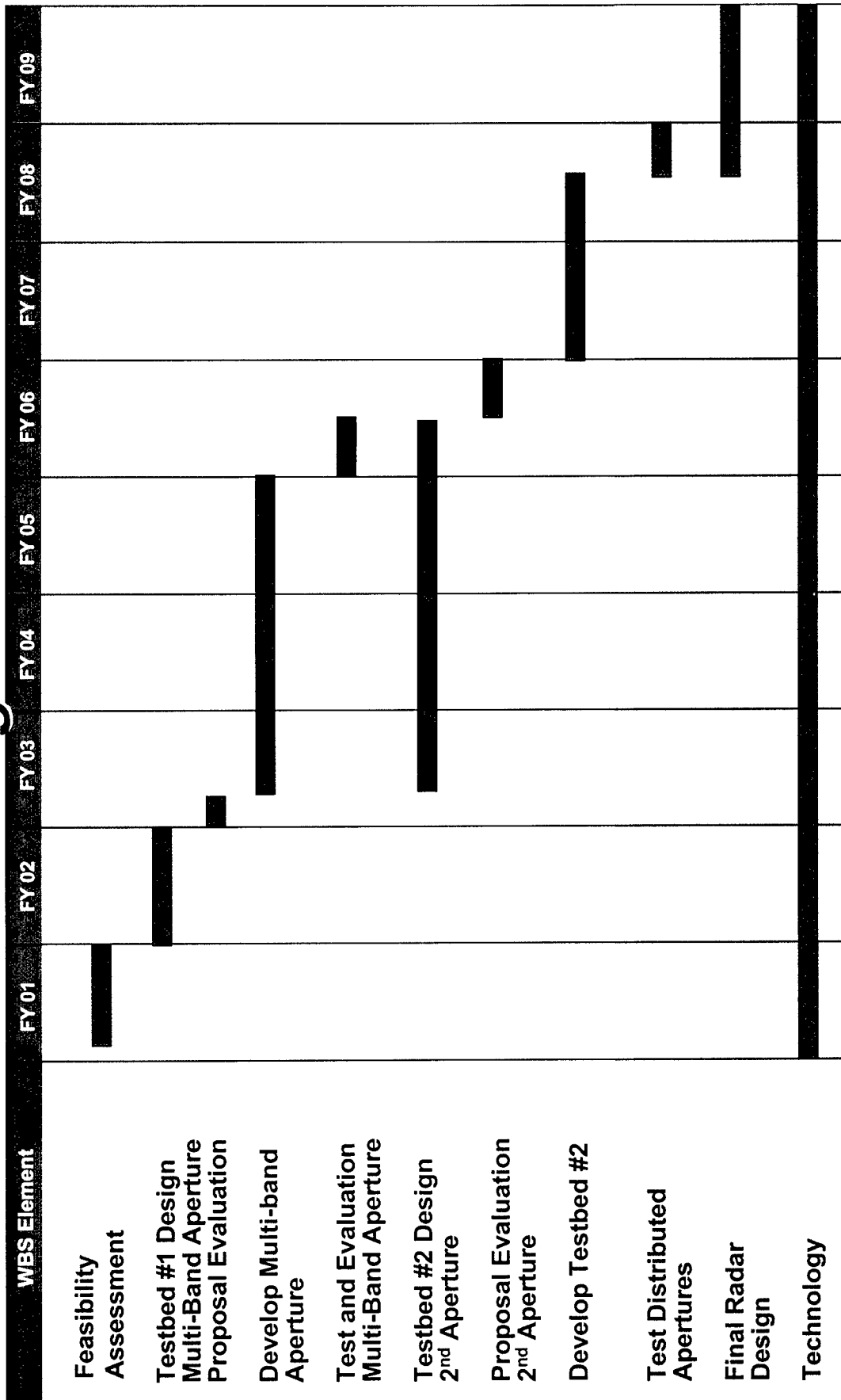


UNCLASSIFIED



*Army Space and Missile Defense Command*

# *Transportable Discriminating Radar Program Plan*



*"Secure the High Ground"*

UNCLASSIFIED



UNCLASSIFIED

*Army Space and Missile Defense Command*



# ***So What's Missing?***

***How do we integrate the requirements,  
analysis, and technology program  
leading to production?***

***System Engineering***

UNCLASSIFIED

*"Secure the High Ground"*



UNCLASSIFIED

*Army Space and Missile Defense Command*



# ***What Are The Metrics?***

***Systematic metric/measurement system that supports assessment of the maturity of a particular technology and the consistent comparison of maturity between different types of technology.***



***Technology Readiness Levels (TRL'S)***

UNCLASSIFIED

*"Secure the High Ground"*



UNCLASSIFIED

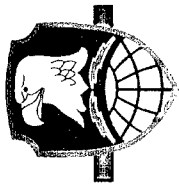
*Army Space and Missile Defense Command*



# Technology Readiness Levels

|                                       |         |   |
|---------------------------------------|---------|---|
| Fundamental Research                  | Level 1 | Basic Principles or Physics Observed and Reported                                 |
| Development to Prove Feasibility      | Level 2 | Technology Concept and/or New Application Identified                              |
|                                       | Level 3 | Proof-of-Concept and/or Analytical/Experimental Characterization                  |
| Technology Development and Maturation | Level 4 | Component and/or Breadboard Validation in Laboratory Environment                  |
|                                       | Level 5 | Component and/or Breadboard Validation in Relevant Environment (Ground or Flight) |
| Subsystem/Component Demo and Testing  | Level 6 | System/Subsystem Model or Prototype Demonstration in A Relevant Environment       |
|                                       | Level 7 | System/Subsystem Model or Prototype Demonstration in A Flight Environment         |
| Flight/Ground Test                    | Level 8 | Actual Component Completed and "Flight Qualified" through Test and Demonstration  |
| Intercept Mission Test                | Level 9 | Actual Component Completed and "Flight Proven" through Successful Intercept       |

UNCLASSIFIED



UNCLASSIFIED

*Army Space and Missile Defense Command*



# Technology Difficulty Index

*Difficulty in Achieving Research And Development (R&D) Objectives*

| Index | Degree of Difficulty     | Probability of Success<br>in "Normal" R&D Effort |
|-------|--------------------------|--|
| TD-1  | Very Low                 | 99%  |
| TD-2  | Moderate                 | 90%  |
| TD-3  | High                     | 80%  |
| TD-4  | Very High                | 50%  |
| TD-5  | Fundamental Breakthrough | 20%  |

- Provides early indication of risk
- Facilitates Prioritization Among Technology Programs In A Constrained Resource Environment

*"Secure the High Ground"*

UNCLASSIFIED

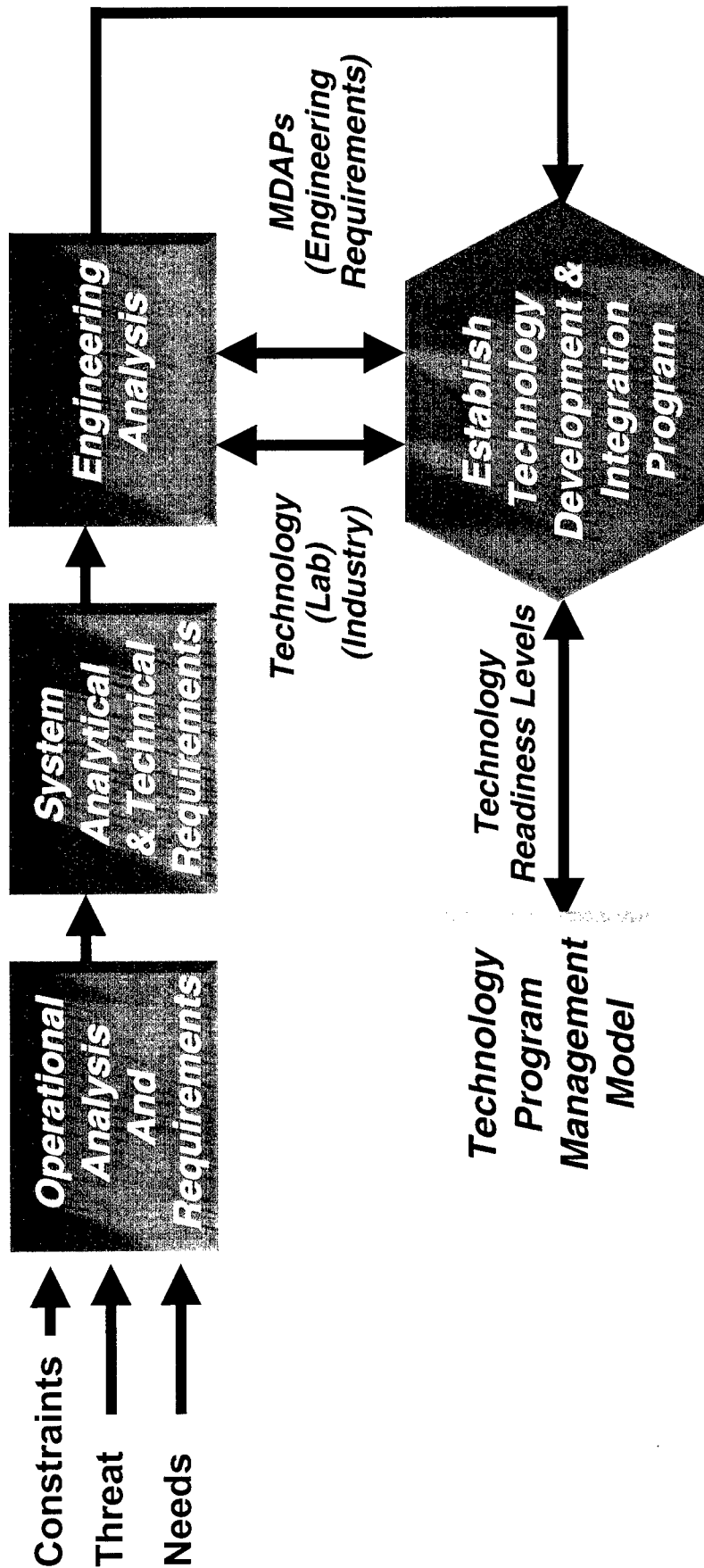


UNCLASSIFIED

*Army Space and Missile Defense Command*



# Process To Develop Technology Program



## Analytically Based Technology Program Defined

*"Secure the High Ground"*

UNCLASSIFIED



UNCLASSIFIED

*Army Space and Missile Defense Command*



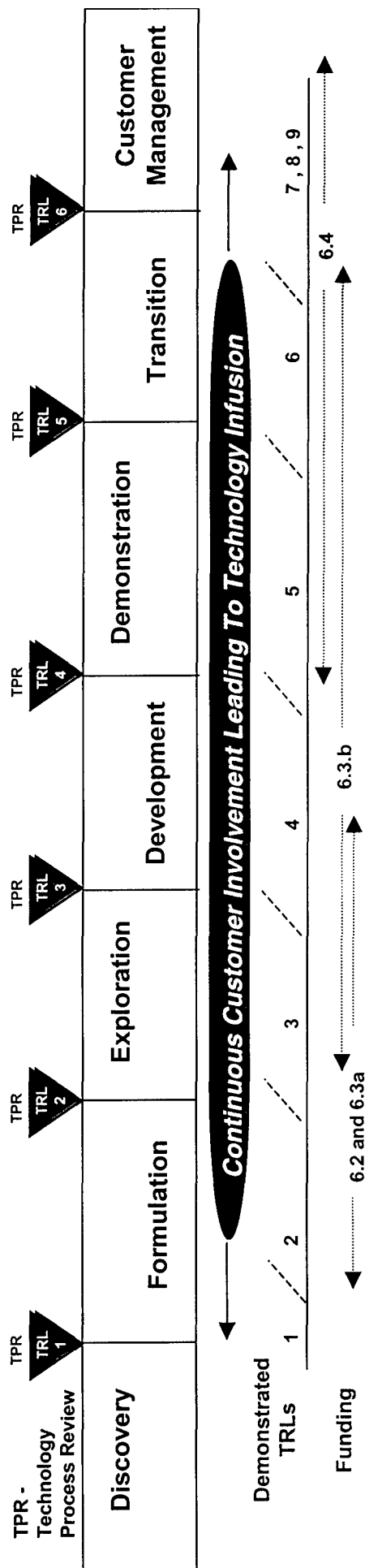
# ***Technology Program Management Model***

- Logical Methodology to *Guide* Technologists Through the Program Planning and Execution Process
- When and Where is the Technology needed – Focus on Requirements
- Determine Military Utility – Identify Potential Customers
- Develop Program Strategy – Program Plan
- Vision for Transition to Program Manager/Major Defense Acquisition Center Programs



# Army Space and Missile Defense Command

# Technology Program Management Model



| <u>Discovery</u>  | <u>Formulation</u>                                   | <u>Exploration</u>  | <u>Development</u>                                       | <u>Demonstration</u>                                      | <u>Transition</u>   |
|---|--|---|--|---|---|
| Develop an Idea Based on Threat, FOC, User Reqmt, Other | Develop a Concept                                    | Proof of Concept  | Demonstrate Key Technologies Work Together               | Demonstrate Components Work With/as System                | Demonstrate Prototype Ready for Operations                |
|   | Perform Paper Studies Model & Simulation             | Conduct Analytical & Laboratory Studies of Key Technologies | Assemble "Ad hoc" Hardware in Laboratory                 | Develop High Fidelity Component or Brass-board in "HWIL"  | Produce Prototype Hardware for a Relevant Environment     |
| Work With Industry, Battle Labs, Academia, Customers    | Determine Technology Difficulty Index                | Non-Integrated "Representative" Laboratory Component Test   | Integrated Lab Test of "ad hoc" or Breadboard Components | Test With Other Elements in High Fidelity Validation Test | Test Prototype as System in Simulated Operational Setting |
| ID Pertinent Application & a Potential Customer         | Determine Military Significance and specify customer | Develop General Requirements                                | Refine Requirements                                      | Finalize Requirements                                     | Demonstrate Increased Capabilities                        |
|   | Cultivate Sponsorship                                | Develop Draft Program Plan                                  | Refine Program Plan                                      | Develop Transition Plan and Gain Customer Approval        |   |

**TAILORED PROCESS PROVIDES FOR STREAMLINING, FLEXIBILITY, AND MULTIPLE ENTRY POINTS**





UNCLASSIFIED

*Army Space and Missile Defense Command*



# Exploration Phase

- Each Phase Needs an Ending and Documentation.....
- Know When Enough Is Enough
- Deliver Key Documents for Each Phase

## Exit Criteria Met When:

- Concept study findings are supported by demonstrated key technology capabilities
- Key preliminary (draft) performance/technical parameters are identified
- Draft Program Plan adequately outlines remainder of the program through transition
- Technology development program cost estimate is reasonable
- Sponsor agrees to fund technology development program
- Customer has been briefed on program
- Program schedule developed

## Deliverables:

- Draft Program Plan
  - 1.1 Proof of Concept Analysis Report
  - 1.2 Draft Requirements Document
  - 1.3 Component/Breadboard Laboratory Validation Plan
  - 1.4 Customer/sponsor briefed and support agreement obtained
  - 1.5 Program funding estimate
  - 1.6 Program Schedule

UNCLASSIFIED

*"Secure the High Ground"*



UNCLASSIFIED

*Army Space and Missile Defense Command*



# Exploration Phase

- Establish a Set of Questions for Each Phase..
  - The Answer Is Not As Important As The Fact That You Addressed the Question
1. What critical functions will be evaluated?
  2. What are the key performance parameters?
  3. What analytical studies will be conducted?
  4. What historical data have been collected and analyzed to determine probability of successful performance?
  5. What laboratory test will be conducted?
  6. What 'representative' components will be used in the test?
  7. Develop/update/validate models and simulations based on studies and laboratory test results.
  8. Prepare a draft program plan.
  9. What is the estimated cost of this technology development program?
  10. Where will the test be conducted?
  11. Who will conduct the test?
  12. Will the customer observe the test or be briefed on the outcome?
  13. What organizations should be involved with this phase?
  14. Develop list of products, specific exit criteria and required funding for all remaining phases/TRLs.
  15. What contracting strategies have been selected for the remainder of the program?
  16. Has a program schedule been developed?

*"Secure the High Ground"*

UNCLASSIFIED



UNCLASSIFIED

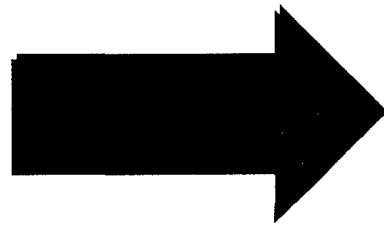
*Army Space and Missile Defense Command*



## ***Final Remarks***

***The System Approach To Technology  
Program Development Is Applicable From:***

***Component Development***



***System Development***

UNCLASSIFIED

*"Secure the High Ground"*